

**Remarks**

Claims 1 – 10 are pending in this action. Claims 1 – 10 stand rejected. Applicants have amended claims 1 and 9 herein. Based on the following remarks, Applicants respectfully request reconsideration of all pending claims herein.

**Claim Rejections – 35 U.S.C. § 103 (a)**

The Office Action stated that claims 1 - 8 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over U.S. Patent No. 6,649,864 issued to De Steur et al. in view of U.S. Patent Publication No. 2002/0096501 issued to Schultz.

The Office Action stated that De Steur discloses laser drilling of holes in a circuit board substrate. A perforated mask is used to drill a hole with a predetermined diameter. During drilling the laser beam is moved in a circular path (wobble motion). The Office Action stated that De Steur does not teach the angle of the wobble motion. The Office Action stated that Schultz discloses the piercing using a laser. The laser beam is focused at an incident angle (0 to 10°) and that this may vary depending on the geometry and character of the material being processed. The Office Action further stated that:

It would have been obvious to one skilled in the art at the time of the invention to determine the angle of the beam relative to the axis as taught by Schultz et al. in the De Steur et al. process because this is merely a measurement of the operational parameters and ensures the formation of a quality drilled product (See Office Action page 2).

Applicants submit that Schultz et al. discloses a method and apparatus for welding and fusing quartz objects by evenly heating the edges of two quartz objects using a laser beam having an incident beam angle 415 of 0-10 degrees. Beam 185 is repeatedly reflected down the length of

channel 420 heating the two surfaces. When each surface reaches the predetermined welding temperature, the two objects molecularly fuse when a joining force is applied (see Schultz fig 4A-B, Fig. 5 steps 530-545, Abstract, Summary, 0061-62, and 0071). Schultz et al. further teaches that for various materials and the geometries of the surfaces to be welded, incident beam angle 415 may vary as much as 90 degrees. Schultz does not teach or suggest using incident beam angle 415 to drill a cylindrical hole. Thus, one of ordinary skill in the art would not be motivated to combine a quartz fusion apparatus having an angled beam with laser hole drilling apparatus for drilling straight, cylindrical holes in circuit boards. The art is simply non-analogous.

Further, Schultz et al does not teach or suggest using an incident laser beam angle to pierce a quartz object and create a cylindrical channel as shown in figures 6A-6D. The movable welding head 180 and beam 185 are perpendicular to the quartz object throughout the piercing process (0° incident beam angle 415). The welding head and beam are placed directly above the inner portion 605 of the quartz object 600 in order to pierce straight downward to reach the inner portion. Upon reaching the inner portion the piercing process is complete and thermal processing of the inner portion commences. Once the thermal processing of the inner portion is complete, welding head 180 is angled incident to quartz object 600 (incident beam angle 415) so that beam 185 can be used to essentially “zip up” or close channel 610 (see Fig. 4A, 6A-C and 7, and 0072-74, 0076, 0081, 0088-89), using the reflective process described by Schultz et al. (see Schultz Fig 4A-B and 5). Applicants contend that **closing** or **filling** a channel or hole is counter to **drilling** a channel or hole. Again, the art is non-analogous.

Finally, Schultz et al. teaches that “the channel may be an opening of **variable geometry caused by altering the beam’s vector as it is applied to the object**. For example, the channel may be **cone-shaped** or cylindrical” (see Schultz 0081). In other words, Schultz et al teaches altering the beam’s vector (i.e. not = 0°) to create a channel having a variable geometry (i.e. cone-shaped). Thus, Schultz et al. teaches away from drilling a cylindrical hole wherein “the laser irradiates said hole from a direction **inclined at a predetermined angle** relative to said perpendicular direction... until **diameters of a top portion and a bottom portion of each of said**

**holes become substantially equal to each other, the sides of each of said holes are substantially parallel to each other and aligned in said perpendicular direction.”** (see Applicant’s claim 1 as amended and Figs. 1A-D).

According to 35 USC 103(a), a *prima facie* case of obviousness must be made from a suggestion or motivation in the references to make Applicant’s claimed invention. It is not enough that one may modify a reference in view of a second reference, but rather it is *required* that the second reference suggest modification of the first reference and not merely provide the capability of modifying the first reference.

Applicants contend that neither De Steur, nor Schultz provide motivation to drill a parallel, cylindrical hole being perpendicular to the surface of a work piece using a laser beam at an angle incident to the work piece. In fact, all of the cited references suggest angling a beam to create a shape whose sides are substantially parallel to the angle of the beam thereby teaching away from using an angled beam to drill a hole whose sides do not correspond to the angle of the beam.

*In re Gurley, 27 F.3d 551, 553 (Fed. Cir. 1994)*, the court stated:

A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. The degree of teaching away will of course depend on the particular facts; in general, a reference will teach away if it suggests that the line of development flowing from the reference’s disclosure is unlikely to be productive of the result sought by the applicant.

The references provide evidence that one of ordinary skill in the art at the time of the invention would not expect an angled beam to produce a hole whose sides do not correspond to the angle of the beam. Therefore, one would avoid, or be discouraged from using a laser beam having “**an angle relative to said perpendicular direction...** until diameters of a top portion and a bottom portion of each of said holes become substantially equal to each other, the sides of each of said holes are substantially parallel to each other and aligned in said **perpendicular direction**”

(see Applicants claim 1).

Examiner's argument that "the angle is a measurement of operational parameters and ensures the formation of a quality drilled product" incorrectly assumes that one of ordinary skill in the art desiring to form a quality drilled product entailing a perfectly straight hole would consider using a beam at an angle incident (i.e. not perpendicular) to the surface of a work piece to produce the desired hole. In fact, at the time of the invention, one of ordinary skill in the art would not have been motivated to create a quality drilled product using the method described in Applicants' disclosure.

Applicants submit that the amendment to independent claim 1 and the arguments described above overcome the rejections of claims 1-8 stated in the Office Action and that Applicants' invention is patentably distinguished from the references cited by the Examiner. Accordingly, Applicants respectfully submit that the rejection of claims 1 – 8 under 35 U.S.C. § 103(a) has been overcome and claims 1-8 are in condition for allowance.

The Office Action stated that claims 9 and 10 stand rejected under 35 U.S.C. 103(a) as being unpatentable in view of Hiramatsu (USPAP 2004/0222197).

The Office Action stated that Hiramatsu discloses a laser system for drilling holes in a work piece, and includes a CO<sub>2</sub> laser oscillator, a condenser lens, a collimator lens, and a transfer mask. The beam is positioned by galvano mirrors which are adjusted by angle adjustment motors and is finally passed through an f-theta lens before impinging on the substrate. Additionally, the system has a target mask, which may be placed on the substrate. The mask may be used to alter the diameter of the laser beam.

Applicants submit that the apparatus disclosed by Hiramatsu does not "teach or suggest all the claim limitations" of the claimed invention as required in the Manual of Patent Examining Procedures ("MPEP") § 706.02(j) (2005) for establishing a *prima facie* case of obviousness. Specifically, Hiramatsu does not teach or suggest the claim limitation of claim 9 as amended, "...a

galvano mirror adapted to change the laser beam passing position of said lens depending on the number of times of laser beam irradiation *to said hole*” (See Applicants’ para 22, 24-29, and figures 1, 3b, and 6). Instead, Hiramatsu teaches angling galvano mirrors for the purpose of drilling a hole in a different location on the board (See Hiramatsu paragraphs 138, 180, 209, and 220, and Figures 1, 6, 7, 12, 16, and 17).

Hiramatsu does not teach or suggest angling the beam (in the z direction) so that it passes through the lens at a passing position which determines the angle of the laser beam relative to the board *for the same hole*. Applicants’ invention angles the galvano mirrors such that the laser is irradiated on a different passing position of the lens, resulting in the laser hitting the board at an angle determined by the location on the lens through which the laser passed (see Applicants’ paragraphs 34, Figs. 3A and 3B, and Claim 9). By repeatedly adjusting the position of the galvano mirrors, the laser moves to a *different passing position on the lens* but still irradiates the board *at the same hole location*, resulting in drilling a straight, cylindrical hole after the multiple irradiations are complete. Hiramatsu teaches that angling galvano mirrors moves the laser irradiation position perpendicularly with respect to the board (i.e. *only* in the x, y direction) and does not angle the beam with respect to the board or the lens (i.e. does not have the capability of changing a z direction) (See Hiramatsu paragraphs 44-45, 47, 50, 52, 71, 75, 81, 87, 101, 179, and 208). Thus Hiramatsu teaches a laser at a perpendicular angle relative to the lens and to the board to drill a hole (See Hiramatsu figures 1, 6, 7, 12, 16, and 17). In fact, Hiramatsu further states that moving the X-Y table, which supports the work piece, has the same effect as moving the scanning head (galvano mirrors) (see Hiramatsu paragraph 173). Therefore, since the table only moves in the X-Y direction it is further evidence that the galvano mirrors only move the beam in the X-Y direction. Thus, any adjustments to the galvano mirrors of Hiramatsu’s apparatus result in the laser irradiating the board at a different X-Y location and hence, a *different hole location*.

In Applicant's claim 10, the condenser lens itself is angled incident to the work piece such that the laser hits the lens in a different "passing position" thus the laser intersects with the work piece at a specified angle and in a specified location (see Applicants' paragraph 48, Fig. 7, and claim 10). Hiramatsu does not teach angling the lens relative to the work piece to change the angle of the laser beam passing position. Further, Hiramatsu does not teach angling the lens at all. Therefore Hiramatsu does not teach or suggest the limitation in Applicant's claim 10: "wherein an angle of said condenser lens is adjustable for changing the laser beam passing position of said lens".

Applicants submit that the amendment to claim 9 and the reasons described above overcome the Examiner's rejections to Claims 9 and 10, and that Applicants' invention is patentably distinguished from the references cited by the Examiner. Accordingly, Applicants respectfully submit that the rejection of claims 9 and 10 under 35 U.S.C. § 103(a) has been overcome and claims 9 and 10 are in condition for allowance.

**Summary and Conclusion**

Based on the foregoing, it is respectfully submitted that the pending claims in the subject patent application are in condition for allowance and that the application may be passed to issuance.

The Examiner is urged to call the undersigned at the number listed below if, in the Examiner's opinion, such a phone conference would aid in furthering the prosecution of this application.

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